round corners which look as if they were sharp angles, is so strikingly unlike anything which can be realized (and the results explained in this section can to a great extent be experimentally realized), that the diagram becomes at least misleading. If the corners are sharp by intention, then the diagram *is* absolutely wrong.

In spite of the faults and defects we have been obliged to notice, this book is, as we have said, an admirable attempt at a very worthy object, and with some remodelling it can be made into an excellent text-book. We wish it all success, feeling well satisfied that it meets a decided want.

OUR BOOK SHELF.

The Dietetic Value of Bread. By John Goodfellow, F.R.M.S. (London: Macmillan and Co.)

THIS book is another addition to the useful series of "Manuals for Students," published by Messrs. Macmillan and Co. The author states in his preface that the object of the work is twofold. First, to lay before the general public an account of the various kinds of bread, by which their merits may be judged; and, secondly, to afford technical information to students and others on the important subject of the true value of bread as a food. These objects have in every way been fulfilled. No one is more qualified to write such a book than Mr. Goodfellow, who by his previous writings has shown such a grasp of the subject with which he has to deal.

The first section of the volume is concerned with "Food, Diet, and Digestion." This is a very difficult matter to treat in a popular manner. It involves some of the most complicated problems of physiology. The author, however, has not shirked his task; anyone, however ignorant he may formerly have been on the processes by which food matters are rendered suitable for absorption and after-use by the human organism, if he reads through these pages carefully, cannot but help gaining much knowledge on the functions of the stomach and intestinal canal, and of the waste and work of the body.

The nature of the digestive fluids is not, of course, considered with the minuteness of detail necessary for a medical examination, but enough is said to render the following sections perfectly intelligible, although they are treated in a scientific manner.

"White Bread" is first considered. An introductory chapter is given describing the structure of the wheat grain, and the changes which flour undergoes when exposed to heat and the process of fermentation. Not only are the chemical and physiological properties of bread considered, but economical principles are gone into, and it is shown "that bread is one of the cheapest foods, not only with regard to the actual weight of nourishment obtained, but also with regard to the variety of the nutrient constituents; and the purchaser who expends his modest 2½*d.* in a 2-lb. loaf may rest assured that he could not spend his money to better advantage."

We further learn, however, that white bread is not a perfect food; those who partake of it should take care to supplement it largely with other foods, in order to make up for the lack of calcareous matter. On no account should it form part of the diet of children unless supplemented by milk or other foods rich in lime and phosphates.

Turning to "Whole-meal Bread," full descriptions are given of its composition, amount and nature of the salts present and their solubility; its digestibility, the waste present, and the action of bran on the intestine; its flavour, satiety, and dryness; and its effects on infants and children.

The ordinary whole-meal bread is not a desirable food, and far inferior to good white bread as regards the weight of actual nourishment and the thoroughness of the digestion. Its ingestion is often followed by diarrhœa, and the action of the bran increases the waste of food.

After a short consideration of some special forms of bread, such as "aërated," "bran," "rye" bread, &c., Mr. Goodfellow proceeds to speak of Meaby's Triticumina bread, of which he has a very high opinion, and believes that it is as near a perfect food as such a bread can be, and deserves the universal commendation which has been accorded to it by the medical and analytical world. "Germ," "diastase," "gluten" bread, &c., are then described, and the book finishes with short chapters on the diseases of bread and its medicinal properties.

To all who are interested in this subject, or wish to extend their knowledge of "the staff of life," we heartily recommend this volume.

Graduated Mathematical Exercises. Second Series. By A. T. Richardson, M.A. (London: Macmillan and Co., 1892.)

ON a previous occasion we have referred to the first series of exercises by Mr. Richardson. In these he led the student through a set of graduated examples, commencing with arithmetic and reaching those on cube root, compound interest, and quadratic equations.

In the present series, which is intended to be a continuation of the first, the relatively higher flights of mathematics have been dealt with. The problems have been arranged on the same lines, the more difficult of them being reached as advance is made, and include those on algebra, logarithms, trigonometry, mechanics, and analytical geometry.

An idea of the range over which each subject spreads can be gathered from the fact that all the problems will about suffice to cover such examinations as those of the Oxford and Cambridge Locals, and Army and Navy, allowing a small margin of safety.

Great care seems to have been taken to insure accuracy, every example having been worked out at least twice. For class work these examples will be found handy and a great saving of time, while for use at home the book should be widely employed.

Bibliothek des Professors der Zoologie und vergl. Anatomie, Dr. Ludwig von Graff, in Graz. (Leipzig: Wilhelm Engelmann, 1892.)

PROF. VON GRAFF is the lucky owner of a fine scientific library, which was formed mainly by Carl Theodor von Siebold, his father, and his grandfather, all of whom were professors. This library came into the possession of Prof. von Graff in 1882, and as it was too large for the modest dimensions of a German professor's house, he exchanged many books relating to practical medicine for zoological monographs and periodicals. At Graz the library is freely used by his assistants, pupils, and colleagues, and it is mainly for their benefit that the present catalogue has been issued. It consists of 337 closely printed pages, and is a compilation of considerable value, not only because it gives lists of authors and their works, but because of the admirable way in which the lists are arranged. The contents of the library are grouped under four headings—periodicals, auxiliary books (including works on University systems, bibliographical writings, dictionaries, &c.), *zoologia generalis*, and *zoologia specialis*.

The Canadian Guide-book. By Charles G. D. Roberts. (London: William Heinemann, 1892.)

TOURISTS and sportsmen in Canada ought to be very much obliged to Mr. Roberts for having provided them with this excellent Guide-book. The method he has adopted is that of Baedeker's Hand-books, and the result is in every way worthy of the models he has chosen. The work includes full descriptions of routes, cities, points of

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interest, summer resorts, fishing places, &c., in Eastern Ontario, the Muskoka district, the St. Lawrence region, the Lake St. John country, the maritime provinces, Prince Edward Island, and Newfoundland. In an appendix are given fish and game laws, and official lists of trout and salmon rivers and their lessees. The author generally compresses his information into as small a space as possible, but in dealing with the more interesting Canadian scenes has sought to make his descriptions lively and attractive. The volume is prettily printed, and is well supplied with maps and illustrations.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Question in Physics.

CAN there be a crowding of the particles of a gas to a much smaller compass without its being markedly heated? Can a gas expand without being cooled? It is probable that nearly every physicist will give negative answers to these questions, and yet the fact that such conditions may occur sometimes seems well established. The present writer, in 1889, attempted to determine the actual heating of air when compressed by a pump connected with the cylinder by a long tube, and found that the temperature was raised about 4° F. for a compression of 10 inches above atmospheric pressure. In like manner, on expanding this compressed air into the free atmosphere, it was found that the cooling was about 4°. These results were published in *Science*, vol. xv. p. 387, and were strongly combated by Prof. Ferrel and Prof. Marvin. Prof. Ferrel advanced, as applicable in this case, the well-known thermodynamic formula for the computation of the heat developed in a gas when compressed, as follows:—

$$\frac{t}{t'} = \left(\frac{p}{p'}\right)^{\cdot 291}$$

in which t and t' are the absolute temperatures corresponding to the pressures p and p'. Sir Wm. Thomson has given this formula in slightly different form, and with a larger exponent (see "Encyclopædia Britannica," vol. vii. p. 814). Prof. Ferrel found that, under the experimental conditions above, the heating should have been 43°, and the cooling 45°? (38°) (see *American Meteorological Journal*, vol. xii. pp. 339 and 340).

It seems very evident, however, that this formula can be used only when all the heat due to the work of compression is concentrated in the compressed air, and conversely when the air expands against an external resistance. An experiment by Joule will serve to elucidate this point. He determined the mechanical equivalent of heat by immersing the cylinder into which the air was to be compressed and the compressing pump in the same water-bath, and then determining the amount of compression and the total heat developed. This enables us to advance the proposition: *If air when compressed is to be raised to the temperature indicated by theory*, it is very *essential that all the heat developed in the work of compression should enter the air.* This seems self-evident; nevertheless, nearly all the errors that have entered the various discussions of this question have arisen from a neglect of this very obvious consideration.

In Joule's experiment let us suppose that the compressing pump had been in one bath, and the cylinder into which the air was compressed in another. Under these conditions, if no heat were lost, the first bath would have received very much the greater amount of heat. Now, if the compressed air in passing from the pump to the cylinder became cooled to the outside temperature, it is evident that all the heat due to the work of compression would have been disposed of outside the cylinder, and would not have been available for raising the temperature of the compressed air.

Instead of connecting the pump directly with the cylinder, let us take two cylinders of the same size, and connected by a tube. Compress the air in the first cylinder (A), to three atmospheres, the air in the other (B) being at atmospheric pressure. If we cool the air in A to the outside temperature, and then open the connection with B, the compressed air will rush from A to B, and an equilibrum will be established very quickly, the pressure in each cylinder being at two atmospheres. The air in A will be slightly chilled because of the work of imparting a certain velocity to the particles entering B, and the air in B will be slightly warmed from the impact of the particles rushing from A, but there will be no heating due to the work of an external force making the compression.

Instead of allowing the air in A to rush into B, suppose we open communication with the outside air. The resistance to the rush of air will be much less than before, and the chilling in A, due to the work of imparting a certain velocity to the air, would be slightly greater than in the previous case, but it is obvious that this will be vastly less than that given by the formula. We may say, then, that the conditions suggested by the questions above may be very easily brought about.

The compressed air in a cylinder has a potential energy or capacity to do work, and this energy may be transmitted to another cylinder having air at atmospheric pressure without loss, and plainly without imparting or losing any heat. We might compare it to the head of water in a pond. This water has a certain capacity to do work depending upon its head. We may enlarge the pond somewhat, and the capacity for doing work will remain almost unchanged. The extremely important bearing of these views upon problems in meteorology is very apparent. The convection theory of storms demands a cooling from the work of expansion in an ascending column of moist warm air; it would appear, however, that the cooling must be vastly less than has generally been considered probable.

H. A. HAZEN.

Aurora.

PERHAPS it may interest some of your readers to see a short abstract of the observations of aurora made here during the last months, this winter having been by far the richest in well-developed northern lights since the winter 1870–71. Beginning with the magnificent display of February 13, which lasted almost the whole night, sometimes with vivid red and green tints (it was first noted at 6h. 45m., and faded away in the moonlight between 15h. and 16h. astronomical time), and whose beams converged several times from a large part of the horizon towards the magnetic zenith (formation of corona was noted at 7h. 2m., 10h., and 13h.), we have had aurora on February 14, 15, 24, 25, March 1 (at 7h. high arch, with the highest part through α and β Cephei, 7h. 55m. corona, between 8h. and 10h. pulsating and flashing light, sometimes with apparently screw-formed motion), March 2, 3, 6 (at 10h. curtains and corona, yellow-green colours), March 24, 25, 26, 27, April 23, 24 (at 10h. 10m. curtains, yellow-green) April 25 (strong light visible through small openings in cumulo-stratus in the north). The last display was on May 1, with corona at 9h. 40m., after 10h. flashes, curtains, and beams, at 13h. beams. About 11h. there was a peculiar downward motion of reddish light near the north horizon.

The magnetic disturbances of February 13 were also the greatest we have had for some years. The magnetometers, of the Gaussian construction, are generally observed at 2h. and 21h., but on February 13 observations were made every hour from 11 p.m., in correspondence with Bosekop in Finmarken, where the German observers, MM. Brendel and Baschin, were taking magnetical observations and photographs of the aurora during February and part of January. In Christiania the perturbations were comparatively small in declination (westerly maximum 12° 35′ noted at 12h. 10m., minimum 11° 42′ at 15h. 18m., but neither of them absolute, the observations not being continuous); but the horizontal intensity, which had already begun to increase a little at 21h., February 12, varied by more than 0·03 C.G.S. units, a maximum of 0·171 having been noted at 2h. 30m., and a minimum of about 0·140 from 12h. 0m. to 13h. 20m.; as the mirror of the magnet was in both cases outside the scale, the values could only be roughly measured. At 16h. 0m. the bifilar had returned to the small end of the scale, but a nearly constant value of the horizontal intensity was only attained after 5h., February 14. The inclination had a maximum of 73° 18′ at 13h. 10m., from which it gradually diminished, with some fluctuations, towards the normal value, about 71° 0′.

With reference to Mr. Backhouse's observation of nacreous

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